Homework question on the board and handout Q1-9
quiz next Thursday Jan 12 eg.
a) initial gravitational energy
E_g=-GMm/r
=-6.67x10^{-11}Nm^2/kg^2 5.98x10^{24}kg 2000kg/6.38x10^6m
=-1.25x10^{11}J

b) final gravitational energy
Eg=
=-6.67x10^{-11}Nm^2/kg^2 5.98x10^{24}kg 2000kg/
(6.38x10^6m+3.59x10^7m)
=-1.89 x 10^{10}J

c) minimum work done by the engines to get to that height(ignore air resistance)
W=change in energy = E_{gf}-E_{gi} = -1.89 x 10^{10}J-
(-1.25x10^{11}J) = 1.25-0.189=1.061 = 1.1 x10^{11}J

d) orbital speed

F_g=ma
GMm/r^2 =mv^2/r
v= root(GM/r)
= Sqrt(6.67E(-11)x5.98E24/(6.38E6+3.59E7))=
= 3.1 x 10^3m/s

e) minimum total energy required (ignore air You want to launch a rocket into orbit around the Earth. If the rocket is 2.00 x 10^3 kg is to be in an orbit 3.59 x 10^7 m away (geostationary satellite) from the surface of the

Earth. Determine

total energy = change in gravitational energy + change in kinetic energy

= 1.061 $x10^{11}$J + 0.5x(2000)x(3100)x(3100)=9.6E9

1.061+0.096=1.157

$1.2x10^{11}$J

f) if half of the minimum total energy required is dissipated as heat by the atmosphere, what is the total energy required?

1.5x1.2=1.8 = 1.8 x 10^{11}J

$1.2x10^{11}$ = x

$2.4x10^{11}$J if half of all the energy is lost

g) How fast do you have to hit a baseball to send it into deep space? (ignore air resistance) Earth's mass=$5.98x10^{24}$kg radius 6.38x 10^6m

where is deep space? assume r=infinity, so Eg=0

no resistive force so

total energy initial = total energy final

Eg+Ek = Egf + Ekf

-GMm/r + $1/2mv^2$ = 0 + 0

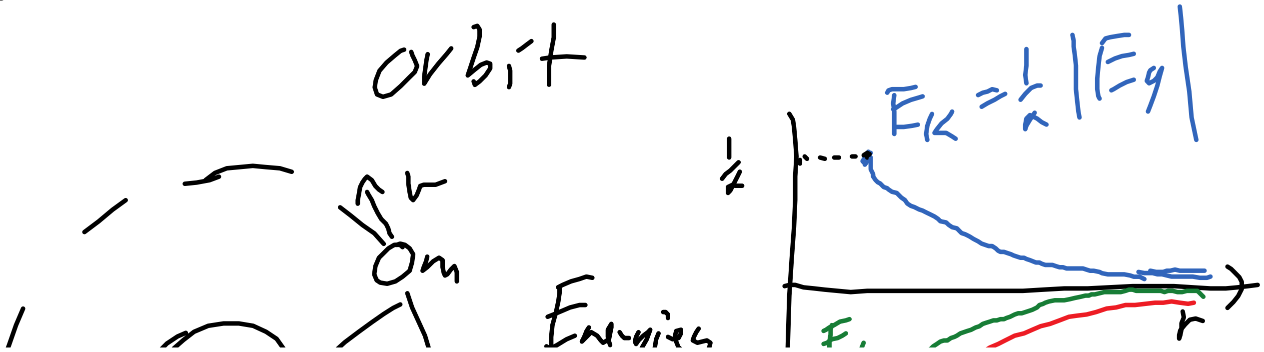
$1/2mv^2$ = GMm/r

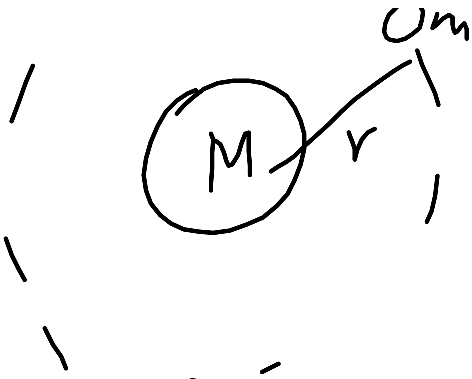
v=root(2GM/r)

v = root(2 $6.67x10^{-11}$($5.98x10^{24}$)/$6.38x10^6$)

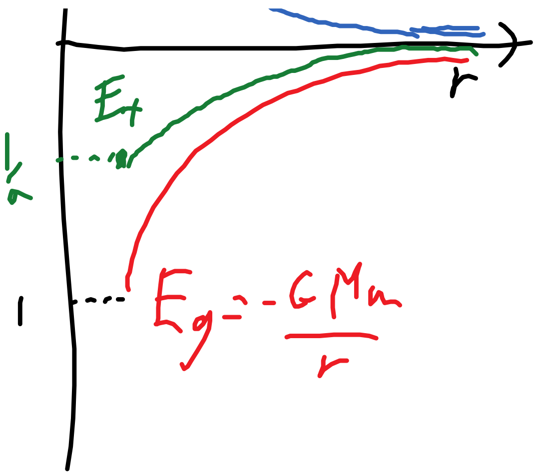
= $1.1x10^4$m/s

Look at Graphing Orbital energies and Projectile energies





Energies



$$E_g = -\frac{GMm}{r}$$

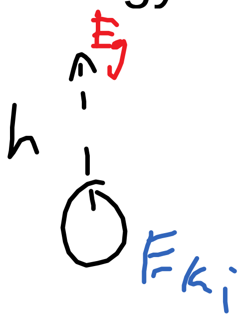
$$E_K = \frac{1}{2} m v^2 \qquad \frac{v^2}{r} = \frac{GM}{r^2} \qquad v^2 = \frac{GM}{r}$$

$$E_K = \frac{1}{2}\frac{GMm}{r} = \frac{1}{2}|E_g|$$

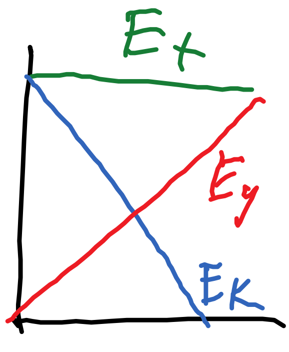
$$E_{total} = E_g + E_K = E_g + \frac{1}{2}|E_g| = \frac{1}{2}E_g$$

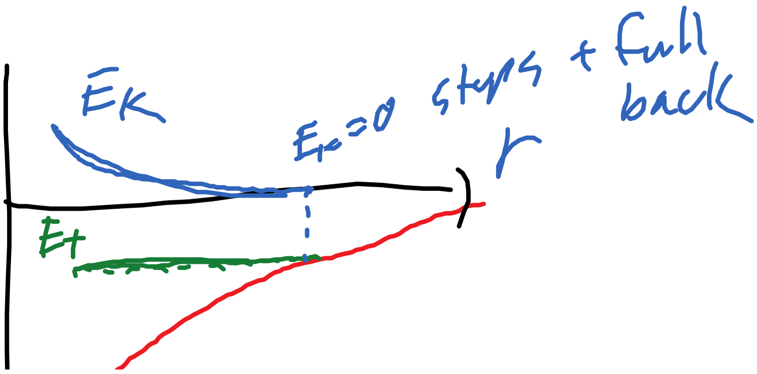
What about the total energy of a projectile?

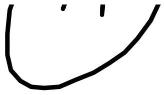
Near Earth



Energies



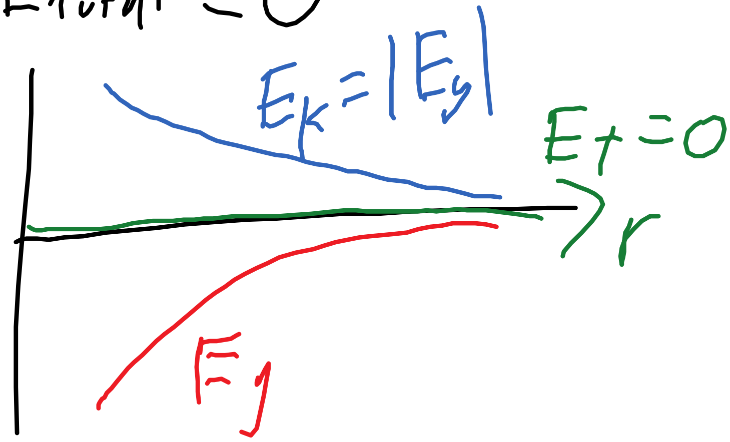




$$E_g = -\frac{GMm}{r}$$

what if we were at escape velocity?

$E_{total} = 0$



eg. The moon has a mass of 7.35×10^{22}kg and a radius of 1.77×10^{6}m. If you are in orbit around the moon at a height of 400km, what is your (if your mass is 50.0kg)

a) gravitational energy in that orbit relative to 0 at infinity?

b) kinetic energy in that orbit?

c) total energy?

d) escape speed from the surface of the moon.

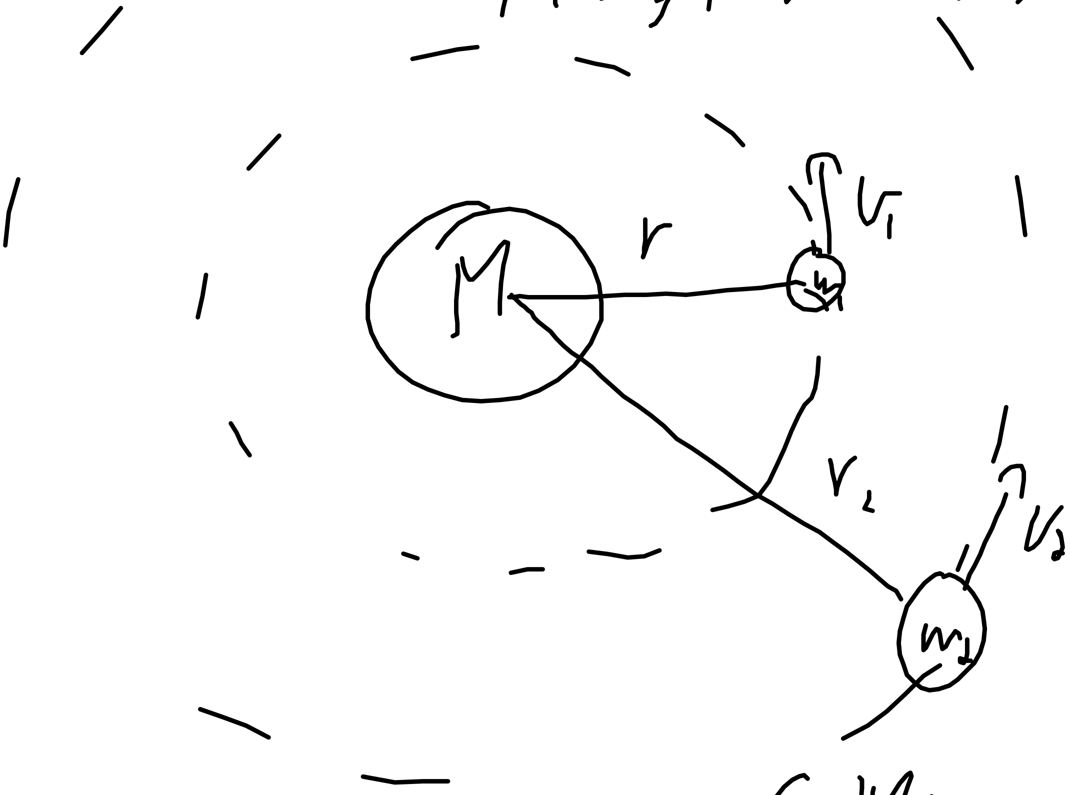
e) if you hit a golf ball from the surface of the moon at 1700 m/s, how high would it go?

rest of the worksheet - go over next class

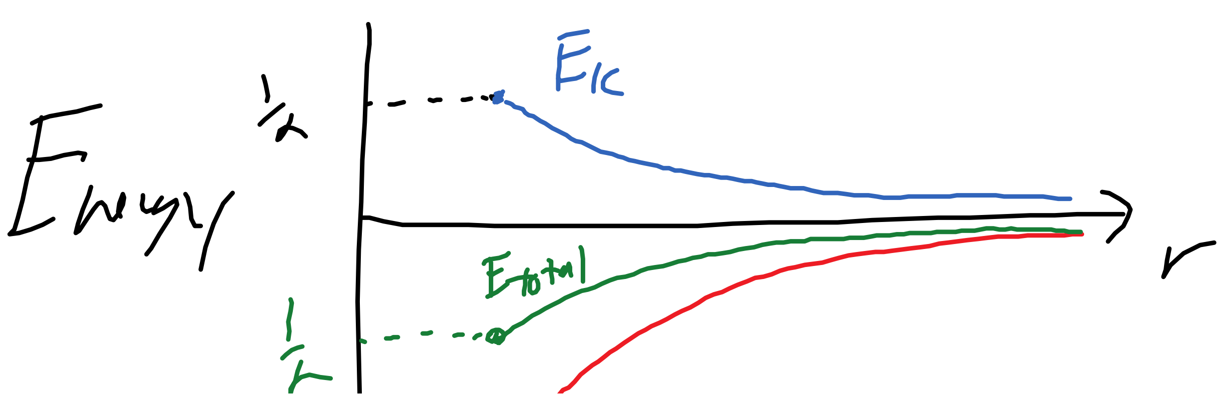
Graphs of E_g, E_K, E_{total}

for 1) orbital motion at various r.

2) Projectile moving through various r



$$F_g = -\frac{GMm}{r}$$



$a_c = g$

$\frac{v^2}{r} = \frac{GM}{r^2} \rightarrow v^2 = \frac{GM}{r}$

$E_K = \frac{1}{2}mv^2 = \frac{1}{2}\frac{GMm}{r}$

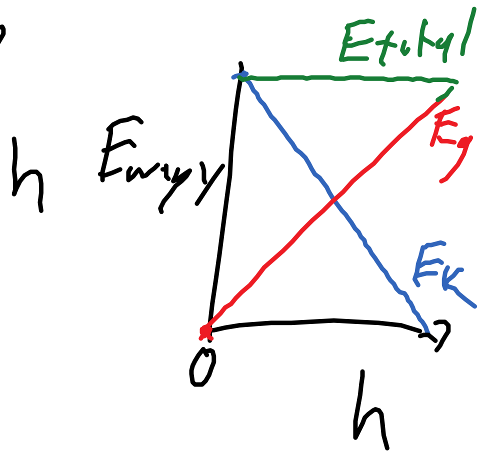
$E_K = \frac{1}{2}|E_g|$ for orbits

$E_{total} = E_g + E_K$

$E_g + \frac{1}{2}|E_g| = \frac{1}{2}E_g$

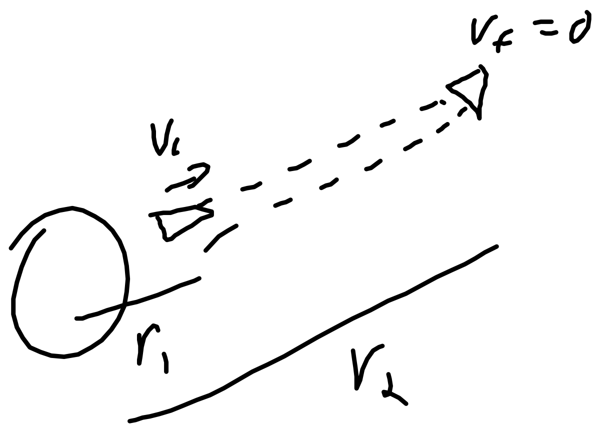
Projectile

Near Earth

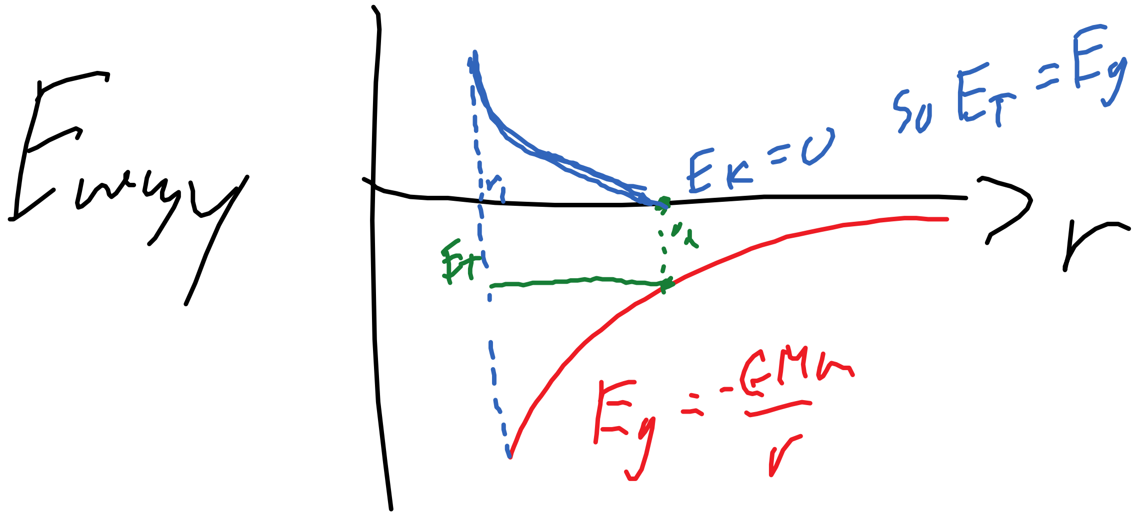


$E_g = mgh$

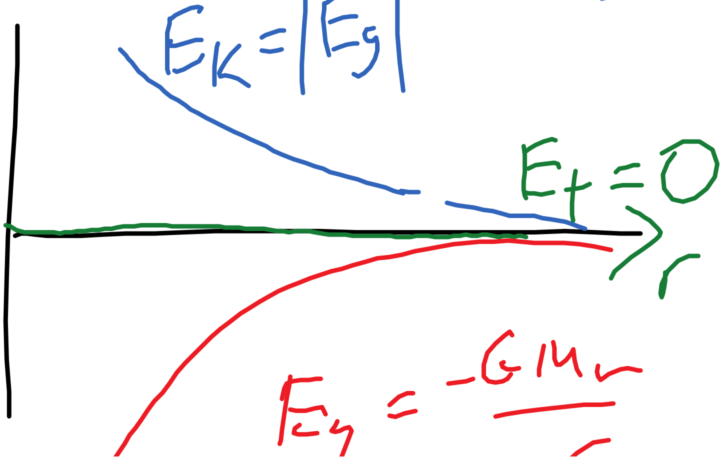
Non-uniform g



$$E_g = \frac{-GMm}{r}$$



escape speed $E_{total} = 0$



$$E_g = \frac{-GMm}{r}$$